STROBE UNIT WITH CURRENT LIMITER

FIELD OF THE INVENTION

The invention pertains to alarm indicating output devices. More particularly, the invention pertains to such devices which emit visual outputs on a periodic basis while limiting peak current requirements.

BACKGROUND

Strobe units are often used as visual alarm indicating output devices in fire alarm systems. As is known, such units emit a high intensity light periodically, for example once a second, to provide an ongoing indication that an alarm condition has been detected somewhere in the region being monitored. One such unit has been disclosed in United States Patent Application No. 10/040,968 filed January 2, 2002 for Processor Based Strobe with Feedback assigned to the Assignee hereof and incorporated by reference herein.

Known units include an energy storage device, for example one or more capacitors, coupled to a gas discharge tube. When the tube is triggered with an appropriate control signal it emits high intensity light while discharging the storage device.

Known strobe units exhibit maximum peak current values subsequent to discharge of the storage element when the tube is triggered. The peak or surge current is primarily due to the fact that electrolytic capacitors in the device need to be recharged for the next flash.

FIG. 1 illustrates a representative timing diagram of peak capacitor recharge current values I_{REP}. These peak current values are of a type exhibited by known strobe units each time the gas filled tube is triggered. At startup, a substantially larger initial current surge I_0, which might be as large as 10 amps is exhibited by known units. In contrast, the peak repeating current values I_{REP} fall in a range of 5 to 7 amps. In contradistinction, the steady state I_{RMS} current typically falls in range of 50 milliamps to 800 milliamps.

It is also known that the magnitudes of the peak initial current surge I_0 as well as the repetitive peak current values I_{REP} vary continuously, from one second to the next, in response to discharge characteristics of the capacitors, the form of electrical energy being supplied to the unit as well as the phase thereof.

In view of the fact that the initial peak current draw I_0 as well as the repetitive peak current draw I_{REP} are exhibited by each of the strobe devices in the system it would be desirable to be able to limit not only the initial peak current surge but also the repetitive ongoing current surges as the unit flashes. Preferably, limiting the amplitudes of the peak current surges can be done without affecting the ability of the units to recharge adequately during the available one-second period to provide the next flash of light. Additionally, it would be desirable if peak current limiting could be achieved without substantial increase in heat generated by the respective strobe units or without substantially increasing the size, cost or manufacturing complexity of such units.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graph illustrating current draw characteristics of an exemplary prior art strobe unit;

FIG. 2 is a block diagram of a strobe unit in accordance with the invention;

FIG. 3 is a graph illustrating reduced peak current draw of the unit of FIG. 2;

FIG. 4 is a partial schematic diagram of one embodiment of the strobe unit of FIG. 2;

FIG. 5 is a partial schematic diagram of another embodiment of the strobe unit of FIG. 2;

FIG. 6 is a partial schematic diagram of another embodiment of the strobe unit of FIG. 2;

FIG. 7 is a partial schematic diagram of yet another embodiment of the strobe unit of FIG. 2; and

FIG. 8 is a system of strobe units as in FIG.2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

While this invention is susceptible of an embodiment in many different forms, there are shown in the drawing and will be described herein in detail specific embodiments thereof with the understanding that the present disclosure is to be considered as an exemplification of the principals of the invention. It is not intended to limit the invention to the specific illustrated embodiments.

FIG. 2 illustrates a device 10 in accordance with the present invention. Device 10, which in exemplary form is illustrated as a warning or emergency indicating strobe unit as an

exemplary application only, incorporates a housing 12 and at least a pair of input terminals 14a,b.

The input terminals 14a, b receive electrical energy and/or control signals from a remote switchable source 16. For example and without limitation, source 16 could provide a reversible 5 to 24 volt input to terminals 14a, b to energize and control the device 10. In a first mode, the power supply 16 could apply a negative 5 volts between the terminals 14a, b which would be a nonoperational condition but could be used for supervision purposes.

To activate the device 10, the source 16 could reverse polarity and couple a plus 24 volts across the terminals 14a, b along with embedded control signals as desired. Those of skill in the art will understand how such systems work in general in connection with warning or alarm indicating output devices wherein a device such as the device 10 could be used.

Device 10 further includes a current sensor 20 coupled to a current regulator 22. An output from the current sensor 20 is also coupled to a comparator 24. A second input to the comparator 24 is received from a set peak current and illumination level element 28. Both the current regulator 22 and the illumination parameter setting element 28 are coupled to charging circuitry 30.

The charging circuitry 30 is in turn coupled to one or more energy storage devices, such as capacitors and/or inductors or the like, 34 as would be understood by those skilled in the art.. The energy storage devices 34 are in turn coupled to a gas filled member or tube 36.

As is conventional in the art, the tube or member 36 can be energized with energy stored in devices 34 and triggered by charging circuit 30, trigger line 30a. When triggered, a device 36, due to ionized gases therein, emits an intense radiant energy output R while discharging the energy storage devices 34.

The process of recharging the energy storage devices 34 causes a greater than normal current draw via terminals 14a, b. A peak value of this current draw can be limited in device 10 as a result of an output 20a of current sensor 20 moving away from a set point established by the set peak current element 28, line 28a. This difference, via comparator 24 is coupled to regulator 22 which in turn increases an input impedance of the device 10 thereby limiting the peak value of recharge or surge current of the device 10.

FIG. 3 illustrates a reduced value of peak recharge current achievable with device 10. FIG. 3 is plotted on the same scale and time base as is FIG. 1. As is apparent from a comparison

of FIGs. 1 and 3, device 10 with the current sensor 20 and comparator 24 providing control inputs to current regulator 22 exhibits a substantial reduction in peak surge current.

The peak repeating surge current I_{REP} of FIG. 1 can be reduced from a range of 5 to 7 amps for example to a selectable range based on the type of application and imposed maximum surge current values as illustrated in FIG. 3.

FIG. 4 illustrates in more detail an exemplary embodiment of current sensor 20, regulator 22 and comparator 24 configured to limit peak surge current in a device such as warning or alarm device 10. As illustrated in FIG. 4, current sensor 20 can be implemented with resistor R1. Comparator 24 can be implemented using transistor Q2. Regulator 22 can be implemented using field effect transistor Q1, a Zener diode Z1 and resistor R2. An output from the drain D of regulator transistor Q1 is in turn coupled to charging circuit 30.

In a normal operating condition, between flashes, where source 16 is applying a positive 24 volt potential to terminals 14a, b as illustrated in FIG. 4, Zener diode Z1 in combination with resistor R2 establish a bias for regulator transistor Q1 resulting in an input current I_{IN} corresponding to the steady state current I_{RMS} illustrated in FIGs. 1 and 3. In this condition transistor Q2 is biased off.

The drop across resistor R1 in combination with current I_{RMS} is insufficient to turn on transistor Q2. Current limiting becomes effective when transistor Q2 turns on. This will occur when the drop across resistor R1 substantially equals or slightly exceeds the voltage necessary to forward bias base-emitter junction of transistor Q2 which will be on the order of about .6 volts. This will take place when the current I_{IN} increases toward I_{PEAK} in response to needing to recharge the energy storage devices 34.

As I_{IN} increases, transistor Q2 conducts which in turn raises the gate voltage at node 22a. Increasing the gate voltage at node 22a reduces the magnitude of the gate-to-source voltage of transistor Q1 which in turn reduces current flow through Q1.

A circuit as in FIG. 4 can be incorporated into device 10 to limit peak surge currents, as in FIG. 3, where only a single candela output is desired from device 10.

FIG. 5 illustrates variable input circuitry 50 usable in device 10. Circuit 50 would in turn be coupled to charging circuit 30. Structural elements common to the circuit of FIG. 4 and the circuit of FIG. 5 have been assigned the same identifiers.

Circuitry 50 includes potentiometer R5 which provides a manually or electrically adjustable analog input, voltage V_B which can be varied to adjust the peak value of the surge current I_{PEAK} which occurs as the energy storage elements 34 are recharged each time the tube 36 is flashed. Voltage V_B is used to adjust and vary current I_0 via a transistor Q3.

In the configuration 50 of FIG. 5, the turn-on point for transistor Q2 corresponds to the voltage drop across resistor R3 plus the base emitter voltage of transistor Q2. In this regard, the transistor Q3, resistor R4 and resistor R5 in combination form a variable current source for the current I_0. Hence, by adjusting resistor R5 the current I_0 can be adjusted which in turn alters the voltage across resistor R3 and the turn on point for transistor Q2. Table 1 illustrates exemplary peak values of input current I_{IN} for configuration 50 for various values of V_B. Those of skill in the art will understand that I_{PEAK} can be varied based on values chosen for R1, R3 and R4.

TABLE 1

V_B (Volts)	I_{PEAK} (mA)
0	200
1	300
2	500
3	700
4	900
5	1100

It will be understood that a variety of circuit configurations could be used to implement a system having a block diagram of the system 10 all without departing from the spirit and scope of the present invention. Similarly, neither specific semiconductor types nor specific component values represent a limitation of the present invention. Those with skill will understand that where the device 10 is intended to provide a multi candela output, the circuit 50 would be adjusted to an appropriate peak current value in accordance with a desired candela output.

FIG. 6 illustrates a circuit configuration 50' with a plurality of different peak surge currents selectable via a mechanical or electrical switch indicated generally at S1. Switch S1 sets the voltage V_B to provide the selected maximum surge current. Via a line 28b indicated in phantom, that setting is also coupled to charging circuit 30 to set the selected respective candela output from member 36. Hence, switch S1 enables an installer to simultaneously set the desired output candela as well as limit the surge current to a predetermined maximum associated with the selected candela output.

Where appropriate, the circuitry 50' can be used to limit initial surge current I_0 to be less than or equal to 10 times the average current I_{RMS} the unit 10 draws. Additionally, the peak surge current I_P can be limited so that it is not greater than 5 times the average current draw by the unit 10, I_{RMS}, between output pulses.

FIG. 7 illustrates yet another embodiment of a circuit 50" which incorporates a programmed processor 54 in combination with the plurality of resistors R5A . . . R5D to set the voltage V_B. Those with skill will understand that data provided to the processor 54 can in turn cause that processor to select one or more of the resistors R5B . . . R5D alone or in combination so as, via transistor Q3, to set the peak surge current for the unit 10 as discussed above.

It will be understood that neither the exact form of current sensor 20 nor comparator 24 are limitations of the present invention.

As illustrated in FIG. 8 a plurality 60 of units 10 such as 10-1,-2...-w could be driven via switchable source 16 through a wire medium, such as medium 16a as might be used in a monitoring or alarm system 62. Such systems have been disclosed and claimed in United States Patent No. 5,598,139 for fire detecting system synchronized strobe lights and 5,850,178 for alarm system having synchronizing pulse generator and synchronizing pulse motion detector both of which were assigned to the Assignee hereof and incorporated by reference herein.

Those of skill will understand that alarm control circuits 64, in response to alarm indicating signals from detectors 66 could cause supply 16 to switch from -5 volts applied to medium 16a, strobe units inactive, to plus 24 volts to activate strobes 60. In such systems, current limiters, as described above are especially advantageous in that they minimize peak surge currents produced by numerous strobe units 10 triggering and recharging at the same time.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the invention. It is to be understood

that no limitation with respect to the specific apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.